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NATURAL REGENERATION OF DOUGLAS-FIR IN CENTRAL MONTANA

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ABSTRACT

Relations between Douglas-fir regeneration and seedbed surface conditions that influence natural restocking were analyzed. Undisturbed duff produced significantly greater number of seedlings per acre than five of seven seedbeds tested.

Douglas-fir stands less than 20 years old are practically nonexistent among timber stands east of the Continental Divide in Montana, where this species currently accounts for more than 40 percent (board-foot volume) of sawmill receipts (Wilson 1964).

We don't know why this problem of inadequate regeneration exists, only that it apparently has evolved in recent years. Before 1950, Douglas-fir established itself fairly regularly in cutover areas among these timber stands, and numerous examples are known where it had established itself in sagebrush types.

We do know Douglas-fir seedling germination and survival are highly dependent on favorable environmental conditions. Proper seedbeds aid in providing such conditions. This paper reports on a study of seedbed surface conditions and compares regeneration under seven different types of seedbed conditions 2 to 7 years after clearcutting.[2]

STUDY AREA

Six logged areas were selected for study on the Helena and Lewis and Clark National Forests both located east of the Continental Divide in Montana. All trees 13.1 inches d.b.h. and larger were harvested on the areas 2 to 7 years previous to study installation. On only one area of the six was all residual material felled following the initial cut. Slash was dozer piled and burned.

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[2]Study was installed and data were collected by C. S. Billheimer, U.S.D.A. Forest Service, Northern Region, Missoula, Montana, and David Tackle, now with the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Stands harvested range in age from 150 to 400 years. An average tree is 18 inches d.b.h. and 80 feet tall, and the largest trees may attain the height of 110 feet.

All of the stands are heavily damaged by spruce budworm (Choristoneura occidentalis Freeman). The area is used extensively as summer range for cattle. Soils are classified as silt and clay loams.

Associated with Douglas-fir are the following species: lodgepole pine (Pinus contorta), whitebark pine (Pinus albicaulis), Engelmann spruce (Picea engelmanni), and subalpine fir (Abies lasiocarpa). Principal understory vegetation includes pinegrass (Calamagrostis rubescens), arnica (Arnica cordifolia), bedstraw (Galium spp.), strawberry (Fragaria virginiana), rose (Rosa spp.), Canadian buffaloberry (Shepherdia canadensis), and snowberry (Symphoricarpos spp.).

METHODS AND RESULTS

Reproduction was sampled at two chain intervals along line transects run across the slope. Each sample point consisted of four adjacent square-milacre quadrats. The following measurements were collected on each quadrat: estimated seedbed condition following logging; percent slope; aspect; number of seedlings by species; and percent stocking in terms of stocked milacre quadrats at each sample point. The seedlings established prior to and subsequent to logging were recorded separately, but only seedlings established after logging were analyzed. Reproduction was defined as trees up to and including 5.5 feet in height. The distribution of the various seedbed conditions was as follows:

Seedbed surface conditions	Milacre quadrats
Grass or herbs	116
Burned	35
Bare mineral soil	107
Brush	57
Disturbed duff	110
Logging slash	120
Undisturbed duff	43
Total	588

The seed source of the sample point was noted by recording estimated distance to nearest seed tree in each of four directions or distance to the nearest timber edge. Seed traps were placed near one of the logged areas in two different years to obtain a measure of the stand's present capacity to produce seeds. Residual stand measurements included height, diameter, radial growth, and age. Soil samples were taken on each area.

Data were analyzed using techniques assuming that sampling units were randomly distributed. Systematic sampling was used instead of random sampling because of the ease of location of sampling units.

Eighty-one percent of all seedlings were Douglas-fir. Little correlation was found to exist between Douglas-fir seedlings and the measured topographic, edaphic, and stand factors. The best multiple regression equation accounted for only 26 percent of the variation in percent of Douglas-fir stocking. Independent variables that explained most of the variation included distance to seed source, years since logging, growth and basal area of residuals, and aspect.

Table 1.--Average Douglas-fir seedlings per acre on various types of seedbeds

Seedbed surface conditions						
Grass or herbs	Burned	Bare mineral soil	Brush	Disturbed duff	Logging slash	Undisturbed duff
95	114	140	316	382	825	1,140

[1]

[1]Means underscored by the same line are not significantly different.

A significant difference was shown between numbers of Douglas-fir seedlings per acre on various types of seedbeds (table 1). Percent Douglas-fir stocking was significantly different on the north and south aspects (20 and 8 percent, respectively). There were no significant differences in stocking between the north and east or between east and south aspects. The number of seedlings per acre on the north, east, and south slopes was 368, 524, and 102, respectively.

On the area where the seed traps were placed seed production was estimated to be 360,000 (1957) and 48,000 (1958) sound seed per acre annually in the uncut timber.

DISCUSSION AND CONCLUSIONS

Results obtained in this study permit conclusions that closely parallel observations noted for Douglas-fir regeneration in the Southwest (Krauch 1956). Central Montana and the Douglas-fir country near Cloudcroft, New Mexico, where Krauch studied this species, are remarkably similar climatically from June to September (Krauch 1956; U.S. Weather Bureau 1965), as shown in table 2. The same variety of Douglas-fir is found on both areas, although in the Southwest the Douglas-fir type is found at elevations ranging from 8,000 to 9,500 feet, as compared to 5,000 to 7,000 feet in central Montana.

Table 2.--Climatic conditions for central Montana and near Cloudcroft, New Mexico

Location	Temperature[1]			Precipitation[1]
	Mean	Mean maximum	Mean minimum	Mean
	Degrees	Degrees	Degrees	Inches
Central Montana	55.3	70.0	40.6	25
Near Cloudcroft, New Mexico	57.0	70.3	43.7	26

[1]For months of June, July, August, and September.

Douglas-fir stocking was significantly lower on the south aspect than on the other aspects. Higher soil surface and air temperatures associated with southern aspects would probably reduce soil moisture and increase susceptibility due to heat injury. Lack of variation on the study areas and number of sample points permitted only a general analysis of aspect and slope in terms of seedling establishment.

Stocking was best on either undisturbed seedbeds or those covered by logging slash. The litter present in undisturbed duff is important in Douglas-fir regeneration for several reasons: it conserves soil moisture, reduces herbaceous vegetation, and protects the seed from rodents and birds (Krauch 1956).

Logging slash provides shade without competing for soil moisture. Shade is an important factor because Douglas-fir seedlings are susceptible to heat injury during the first year (Krauch 1956; Isaac 1938). Shade not only reduces soil surface temperature, it also conserves soil moisture, reduces herbaceous vegetation, regulates seedling transpiration (Krauch 1956), and protects the seedlings from cattle, although this was not determined in the study.

The best variables in the multiple regression equations dealt with quantity of seed placed on the areas. Thus, it would seem that future research should be directed toward factors that influence the quantity of seed reaching the ground. The effects of cone and seed insects and defoliation by spruce budworm also should be studied.

For example, spruce budworm was prevalent in the stands and no doubt influenced the amount of viable seed dispersed on the area. In addition, seed and cone insects probably had a detrimental effect on seed production. We already know rodent and bird populations can be a determining factor in natural regeneration (Krauch 1945, 1956; Smith and Aldous 1947).

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